



TITLE:

結び目とソフトマター物理学:高分子のトポロジー、そして物理学、数学および生物学における関連する話題

AUTHOR(S):

CITATION:

結び目とソフトマター物理学:高分子のトポロジー、そして物理学、数学および生物学における関連する話題. 物性研究 2009, 92(1): 1-5

ISSUE DATE:

2009-04-20

URL:

<http://hdl.handle.net/2433/169131>

RIGHT:

研究会報告

(YITP-W-08-08)

結び目とソフトマター物理学： 高分子のトポロジー、そして物理学、数学 および生物学における関連する話題

(2009年3月9日受理)

日時：2008年8月26日(火) — 8月29日(金)

場所：〒606-8502 京都市左京区北白川追分町 京都大学基礎物理学研究所・パナソニックホール

内容：環状高分子とは、ひも状の高分子鎖の両端が閉じて輪形になったものである。そのトポロジーは結び目で表わされる。環状高分子が形成された後にはそのトポロジーは変化せず、熱揺らぎの中で一定に保たれる。トポロジーの効果は例えば高分子溶液のマクロな物性に出現し、最近、実験的にも詳細に解析可能な状況となってきた。結び目の高分子はDNAやタンパク質さらには合成高分子など様々な分野で研究されており、また、結び目の数学や統計物理学など関連する理論分野の発展も著しい。数学と生物学の境界領域における発展も興味深く、自然科学の複数の分野が結合して全体が発展する様相を示している。環状高分子におけるトポロジー効果の研究は、まさにこれからピークを迎えつつあると言える。このような時期に京都大学基礎物理学研究所において「結び目とソフトマター物理」の国際会議が開催されたことにより、基礎物理学および関連する自然科学分野に幅広い視点が導かれ、さらには国際的な研究交流が分野横断的に行われた。

世話人：出口 哲生 (お茶の水女子大学)、今井 正幸 (お茶の水女子大学)、高野 宏 (慶応大学)、
下川 航也 (埼玉大学)、津留崎 恭一 (神奈川県産業技術センター)、
Andrzej Stasiak (アンドレイ・スタシアク、ローザンヌ大学 生物学・薬学部)

Knots and soft-matter physics:

Topology of polymers and related topics in physics, mathematics and biology

Date: Aug. 26 – Aug. 29, 2009

Place: Panasonic Auditorium, Yukawa Hall, YITP, Kyoto University, Kyoto, Japan.

Outline:

Recently, topological effects of ring polymers have attracted much attention in various fields of science such as physics, biology and chemistry. DNA knots, knots in proteins, and synthetic ring polymers have been extensively studied not only theoretically but also experimentally. Furthermore, their properties are described in terms of their topology. The topology of a ring polymer is described by its knot type, and it does not change under thermal fluctuations. The topology of polymers may affect the macroscopic properties of the system, and it is particularly interesting in soft matter physics.

In the workshop “Knots and soft matter physics: topology of polymers and related topics in physics, mathematics and biology”, participants exchanged their knowledge and ideas with many researchers of various different backgrounds, and thus contributed to the development of this interdisciplinary branch of science.

Organizers Tetsuo Deguchi (Ochanomizu University), Masayuki Imai (Ochanomizu University), Hiroshi Takano (Keio University), Koya Shimokawa (Saitama University), Kyoichi Tsurusaki (Kanagawa Industrial Technology Institute), Andrzej Stasiak (Universite de Lausanne)

Contents

- はじめに： 国際研究会「結び目とソフトマター物理」について
(Introduction to the workshop: "Knots and soft-matter physics")
... T. Deguchi (出口 哲生)

- Aug. 26 (8月26日講演)
- Almost unknotted embeddings of graphs and surfaces ... S.G. Whittington
- On a complexity of a spatial graph ... Akio Kawauchi (河内 明夫)
- On algebraic knots I -Computatability of Their Jones Polynomials-
... Yuanan Diao, Claus Ernst, and Uta Ziegler
- On algebraic knots II -An upper bound on their ropelength-
... Claus Ernst, Yuanan Diao, and Uta Ziegler
- A brief review of results on the linking probability for 2-component links which span a lattice tube
... C. E. Soteros
- Shapes of knotted cyclic polymers
... Eric Rawdon, John C. Kern, Michael Piatek, Patrick Plunkett, Andrzej Stasiak,
and Kenneth C. Millett
- Knot spectrum of confined self-avoiding rings
... Cristian Micheletti, D. Marenduzzo, E. Orlandini, and D. W. Sumners

- Aug. 27 (8月27日講演)
- Magnetic writhe and self-organized braiding ... Michell A Berger
- Topological mechanism of nucleation of cyclic polyethylene
... Shinichi Yamazaki (山崎 慎一), Shouichi Ida, and Kunio Kimura
- Topological effect on polymer crystallization of linear and ring polymers
... Norimasa Okui (奥居 徳昌), Noriyoshi Ohno, Susumu Umemoto,
and Yasuyuki Tezuka
- Mechanical Unfolding of a Knotted Protein Studied by Atomic Force Microscopy
... Atsushi Ikai (猪飼 篤)

- Coil-globule transition and knottedness in homo- and heteropolymers
... Peter Virnau, Daniel Bölinger, and Hsiao-Ping Hsu
- Stretching of the knotted protein YibK and its unknotted constructs
... J. I. Sulkowska, Piotr Sulkowski, P. Szymczak and M. Cieplak

Aug. 28 (8月28日講演)

- Packing a semi-flexible molecular chain
... K. Yoshikawa (吉川 研一)
- Scaling of double and single stranded DNA
Exponents and distributions
... Giovanni Dietler
- Bullied no more -When DNA shoves proteins around-
... Lynn Zechiedrich, Graham L. Randall, DeWitt L. Sumners,
and B. Montgomery Pettitt
- Inhibitory effect of DNA supercoiling on DNA knotting
... Andrzej Stasiak, Julien Dorier, and Yannis Burnier
- Tangle analysis of DNA unlinking by the Xer/FtsK system
... Koya Shimokawa (下川 航也), Kai Ishihara, and Mariel Vazquez
- Simulating Polymers in Sheared Drops
... O. Berk Usta, Julia M. Yeomans, and Anna C. Balazs
- Monte Carlo simulation of nematic liquid crystal in porous media: The topological constraint and surface anchoring effect
... Takeaki Araki (荒木 武昭), Marco Buscaglia, Tommaso Bellini, and Hajime Tanaka
- Average structures of a single knotted ring polymer
... Shinya Saka (坂 慎弥) and Hiroshi Takano
- Intrinsic viscosity of knots in solution evaluated through the Brownian dynamics
... Naoko Kanaeda (金枝 直子) and Tetsuo Deguchi
- Linking probabilities of self-avoiding polygons
... Naomi Hirayama (平山 尚美) Kyoichi Tsurusaki Tetsuo Deguchi

Aug. 29 (8月29日講演)

- Knots and links in physical systems
... Thomas W. Kephart, Roman V. Buniy, and Martha J. Holmes

- Stiff knots
Relating topology to geometry and mechanics ... Olivier Pierre-Louis
- An application of linking probability to topological effects of polymer systems : rubber elasticity ... Kyoichi Tsurusaki (津留崎 恭一)
- The configuration space of equilateral and equiangular polygons with up to 6 vertices
(等辺等角 n 角形の配置空間 ($n \leq 6$)) ... Jun O'Hara (今井 淳)
- Unknotting numbers of diagrams of a given nontrivial knot are unbounded ... Kouki Taniyama (谷山 公規)
- Minimal step number of knots with small crossing number ... Kai Ishihara (石原 海)
- The hierarchical structure of chromatin
-Nucleosomal array reconstitution with ring and linear DNA-
... Sumiko Araki (荒木 須美子), Kenichi Yoshikawa, Kohji Hizume, and Kunio Takeyasu
- On the criticality of random knots at the θ temperature -A preliminary report-
... Tetsuo Deguchi (出口 哲生), Yoko Akita, and Akihisa Yao

Posters (ポスター発表)

- Rational structure on algebraic tangles and closed incompressible surfaces in the complements of algebraically alternating knots and links ... Makoto Ozawa (小沢 誠)
- Pseudo diagrams of knots, links and spatial graphs
(結び目, 絡み目及び空間グラフの準射影図について) ... Ryo Hanaki (花本 良)
- Relaxation of a single knotted ring polymer. Shinya Saka (坂 慎弥) and Hiroshi Takano
- Topological effect in ring polymers studied by Monte Carlo simulation
... Jiro Suzuki (鈴木 次郎), Atsushi Takano, and Yushu Matsushita
- Diffusion of circular DNA in solution by Brownian dynamics
... Naoko Kanaeda (金枝 直子) and Tetsuo Deguchi
- Diffusion of supercoiled DNA and the effect of base-flipping by Brownian dynamics
... Naoko Kanaeda (金枝 直子) Tetsuo Deguchi, and Lynn Zechiedrich